DOCUMENT RESUME

ED 280 448 IR 012 584

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TITLE Feasibility Study on the Use of Computer Managed Learning in Secondary Schools in the U.S.A.
SPONS AGENCY United Nations Educational, Scientific, and Cultural Organization, Paris (France). Div. of Structures, Content, Methods and Techniques of Education.
PUB DATE Feb 84
NOTE 32p.; A chart contains marginally legible print.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Case Studies; *Computer Assisted Testing; *Computer Managed Instruction; Computers; Diagnostic Teaching; Elementary Secondary Education; Feasibility Studies; *Individualized Instruction; *Microcomputers; *Recordkeeping; School Districts; *Time Sharing
IDENTIFIERS Comprehensive Achievement Monitoring; Instructional Management Systems; Minnesota; Pennsylvania (Philadelphia)

ABSTRACT

A brief description of computer managed instruction (CMI), including its applications and capabilities, introduces case studies of schools in the United States that are using three different CMI systems. The first system discussed is the Comprehensive Achievement Monitoring (CAM) Program, which was developed by a small school district (Hopkins, Minnesota) for a time-sharing system, and is now being used in a microcomputer. The microcomputer version has been redefined as the Mastery Management System (MMS). The second system--the Instructional Management Program (IMP)--is being used in a large school system in a number of schools, still in a time-sharing system, but adaptation for a microcomputer is being investigated. The third system is a generalized management system which was developed by a publisher for sale to schools. Developed for the microcomputer, this system is restricted in the number of students and the amount of data it can handle, but it is in use in many U.S. schools, and is included in this report as typical of what is being sold in the United States. Each case study presents a brief description of the program as well as an analysis of its basic operations, ways in which the program is being used, and information about the system that is distributed to students. The paper concludes with a summary of the capabilities of CMI, e.g., the generation and scoring of tests, managing instructional resources, and data management. Several diagrams and charts are provided in the case study of IMP. (BBM)

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Division of Structures, Content, Methods and Techniques of Education

Paris, February 1984
Original: English

FEASIBILITY STUDY ON THE USE OF COMPUTER MANAGED LEARNING
IN SECONDARY SCHOOLS
IN THE U.S.A.

by
Dr. Sylvia CHARP

U.S. DEPARTMENT OF EDUCATION
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COMPUTER - MANAGEMENT INSTRUCTION

Introduction

The use of the computer to assist in instructional management with the emphasis on management, not on the delivery of instruction, is a means of individualizing instruction. This involves testing, generating of prescriptions based on needs and the keeping and producing of reports. This is known as Computer Managed Instruction.(CMI)

The process of learning is most effective when instruction is structured. This kind of instruction provides:

- The establishment of learning objectives
- Proper placement of students
- Continuous diagnosis and monitoring of individual progress
- Adaptation of individual learning styles through a variety of specific techniques and materials
- A dynamic interrelationship among all elements in the learning process.

Testing is necessary in some form and appraisal is required so that students may proceed based on their performance. A frequent testing generates a great amount of information, monitoring of student's progre becomes essential and reports on the effectiveness of various learning resources must be made available. Assignments must be based on appraisal of needs and records kept. CMI provides the means by which students can work individually or work prescribed for them. CMI uses testing for the purposes of determining which learning activities would be most beneficial and whether the student is ready for more advanced material. CMI system make decisions based on student mastery as determined by specific objectives. The test items used are chosen at random from a pool of items Each item may be weighted for relative difficulty, coded for various parameters, and related to other questions. In CMI, the student can enter his answer through optically - scanned answer sheets or forms and on-line using computer terminal the students can enter his answers through a terminal, the computer judges its correctness, preseats feedback which can be prescriptive. "Tailored testing" is a procedure by which questions are asked based on previous question...the method requires sophisticated scoring procedures to determine mastery status.

Innumerable reports can be generated which provde valuable information . Example: student progress, mastery of objectives, dates of achievements, post and current assignments are available. However, large data bases do require large systems and the introduction of the microcomputer has reduced their data bases.

CMI system make their best contribution in the generating of prescriptions which are challenging, motivating, but within the student's capability

They may vary in approach, difficulty level and type of resource used, in order to best fit the student's needs. The student can make his own selection and use a number of resources. It is information about the student that leads the system.

The major goal of using CMI has been to assist in the clerical functions thereby freeing the instructor to work more closely with individual students; many systems do achieve this goal. The capabilities of computers make it possible to achieve new instructional models. CMI is not new, its developers worked with large systems to achieve the manipulation of data required to produce the desired reports. The introduction of the microcomputer has introduced other sets of problems both in the handling of the data itself and the restrictions in the amount of data that can be stored.

This report will describe three CMI systems that are in operation in the U.S. One system was developed by a small school district for a time-sharing system, and is now being used in a microcomputer. The second system is being used in a large school system on a number of schools, still on a time-sharing system but investigation is going on to adapt it to a microcomputer. The third system is a generalyzed management system developed by a publishing company for sale to schools and is in use in many schools in the U.S. This system was developed for a microcomputer and is therefore restrictive in the number of students and the amount of data it can handle. It is included in this report as one of the Case Studies and as typical of what is being sold in the U.S. for a Generalyzed Management System on a microcomputer using stand-alone systems. As networking becomes affordable, and more computer power becomes available, this system will probably include additional features. The schools visited that are using the system, are pleased and see an improvement in the student's performance.

CASE STUDY I

Overview

In Hopkins, a Minneapolis, Minnosota suburb, a Comprehensive Achievement Monitoring (CAM) program has been effect since 1970. The Hopkins School District services approximately 10,000 students and employs over 500 teachers. Subject matters involved in the monitoring system include mathematics, science, social studies, english, reading and music.

System is based on objectives and test items (over 25,000 have been developed)

Operation

The use of computers has saved countless hours of teacher time, assuming clerical functions that might ordinarily be that of the faculty. A special feature of the program is that of regular testing - usually every two weeks, with tests corrected by a computer and returned to the classroom within 24 to 48 hours. Thus both teachers and pupils are continually informed about how welll or how poorly they are doing in course objectives tested. Parents examining the test results have been able to see their child's academic weaknesses and offer assistance in those areas that need attention. The teacher is given a report indicating the percentage of students answering each item correctly. If a particular item was answered correctly for only 30% of the class, the teacher will spend class time reviewing the objective which that item tests. If 90% of the students got that item correct, the teacher suggests that the few who missed it do some reviewing or ask for additional help. CAM thus becomes a management tool for the teacher to use in the classroom. Research has indicated that students using this system produced significantly higher scores in mathematics computation and mathematics concepts than did those students not using CAM. The success of CAM is attributed to classroom management by objectives.

The goals and objectives

To establish and maintain a program evaluation which produces the following outcomes:

(1) Students involved in classes using the system will achieve significantly higher than students not involved in the program.

(2) Students involved in classes using the system will find it to be a useful technique for monitoring their progress in the course.

(3) Teachers using the system will find it a useful technique for managing classroom instruction.

Teachers and computer instructional professionals worked together to develop course objectives and test items. Students are given choices for answering questions on an answer sheet.

Test data are fed into a computer terminal where, when the system was first installed, the information was sent to the computer housed 21 miles away. For economic reasons, the computer was shared with 50 other school districts through a cooperative arrangement. (In 1978, CAM began making plans to run project on a microcomputer and input to be accomplished through a keyboard and an optical scan card reader).

To test students a teacher asks for a test covering specific objectives. Most tests contain 20 to 30 items and are thought of as mini-finals, because each test is cumulative - the tests are really three tests in one, dealing with retention of material presented from the beginning of the course, material recently taught and not yet taught. The teacher receives information on individual students along with summary data and item analysis and is thereby enable to make several kinds of decisions for improving the course. While CAM is favored by an overwhelming majority of students, teachers and parents, it was not initially greeted with enormous enthusiasm. Some faculty were reluctant to change old patterns, until the practical, time-saving usefulness of CAM persuaded them otherwise.

If CAM tests, especially the pre-test items show teachers that students already know most of the important objectives of a upcoming unit, that unit is either omitted or altered to avoid boredom. CAM also indicates those places where review might be needed or suggests that a teacher may not have been effective in presenting certain material to the class. CAM results inform teachers where to allocate instructional time. When students are working on individualized instruction material the teacher selects the CAM test best suited to the material which is being studied in order to determine how the student is progressing. Some students will continue to work well by themselves, while others need additional assistance from the teacher.

Each student's progress, or lack of it is noted on separate sheets of paper. The paper contains the pupil's identification number. It maintains a constant monitoring of achievement on each test. The percentage correct in items tested is noted as well as the percentage correct on all "YES" items. A "YES" item is an objective that has been taught and therefore, one the student should know. The sheet also indicates by coded number the objectives, each followed by a plus sign if the student knew the answer and that particular question or a minus sign if not, and whether or not the question was a "Yes" item. Also recorded are cumulative results indicating the test period, the student's percentage of correct answers on past CAM tests and the percentage of "yes" items correctly answered. Normally, the percentage of correct "Yes" items exceed the percentage of total correct because those objectives have already been taught.

Parents are given booklets explaining objectives so that if their child brings the paper home, they and their child can review it together. The teacher receive a sheet of paper which lists all the students, their student numbers and their scores on all CAM tests. It serves as a class record and gives the teacher an accurate profile of students' progress. This monitoring system is taught by the faculty as a "helping device"; helping them teach and the student learn.

In 1980, the CAM program was made available for the 48IK Apple II microcomputer. The system utilized five files and required the storage of about fifty thousand characters of data. The following arbitrary limits had been established for each course listed.

1.	number of students	200
2.	number of student objectives	100
3.	length of test form	50 items
4.	number of test form	10
5.	number of test periods	10

The limits were considerably smaller than those on the original time-sharing system and stored historic data rather than recalculate it. The process reduced the storage necessary and makes it possible to store all data on one floppy disk.

The CAM system was redefined as the Mastery Management System (MMS)

Course Parameters

1. Objectives per course - 400 maximum

   (a) four digit objective number
   (b) two digit item number

2. Test answer - 50 maximum

   (a) two digit test form identifier
   (b) number of questions per test form - - 50 maximum

3. Test periods per course - 20 maximum

4. Course identifier - 5 digit maximum

5. Instruction completion or post-test information

   (a) by objective
   (b) by class or course (not individual students)

Student Parameters

1. Teachers per course - 4 maximum

   (a) length of teacher name - 10 characters

2. Student per course - 900 maximum
   200 maximum per teacher'student group

   (a) student number - 3 digits
   assign alphabetically by teacher

   - numbers 100 - 299 = teacher #1
   - numbers 300 - 499 = teacher #2
   - numbers 500 - 699 = teacher #3
   - numbers 700 - 899 = teacher #4

   (b) student name - 17 characters
   maximum (last, first, initial)

Reports Available

1. Student Forms (with or without help)
2. Student Status Report
3. Teacher Summary Report
   (listing by teacher alphabetically)
4. Group Summary Report

   (a) by teacher
   and
   (b) by "all students"

5. Course Summary Report
6. Study Helps Report

Computer Hardware

Equipment Requirement

(a) Apple II microcomputer with
48K user memory plus Apple
soft BASIC

(b) Dual Mini-floppy disk drives
(5¼" diskettes)

- disk one - CAM programs
- disk two - course information
database, one diskette per
course

(c) Dec. writer as output terminal

Mode of equipment operation

(a) Input of all data will be by keyboard or optical scan equipment
(b) Output will be printed on Dec writer terminal or card reader

MMS is being used in the following fashion .....

Goals are Defined	Instructional goals or objectives are defined and assigned mastery and partial mastery levels.
Test Items are Developed	Multiple choice test items for each objective are developed.
Test are Constructed	Test of one or more objectives are constructed.
Data is Fed to Computer	The predetermined objectives and mastery levels, answer key information and student identification data are entered into the Mastery Management System at the terminal.
Tests are Given	Paper and pencil tests are given Following the test, student responses are entered into the computer by keyboard or by a card reader.
The Computer Processes	Mastery Management System scores the test, determines the student status relative to the mastery level on each objective tested and updates the student information to indicate current mastery status.

What is C.A.M.?

C.A.M. stands for "Comprehensive Achievement Monitoring." It is a new idea that will help you, the student, and also your teacher keep track of how well you are learning in this course.

What Does C.A.M. do for you, The Student?

1. You will be given your first C.A.M. test very early in the course, almost before you have been taught anything. This is to show what you know at the beginning of the course. You can find out what things you need to learn. You know what to work on.

2. From C.A.M. you will discover what things you know before they are taught. This will keep you from doing work that you don't have to do.

3. For the old tests you were supposed to know almost everything on the exam. With C.A.M., however, your teacher will not expect you to get every question right. C.A.M. is a different kind of test, and your teacher knows that many questions cover things that you haven't yet studied.

4. C.A.M. helps you study better. You know exactly what things you need to study, so C.A.M. helps you organize your studying.

5. C.A.M. should make your class better. The teacher will be able to skip boring repetition of things that you understand and spend more time on things which are difficult for everyone. So C.A.M. not only makes your own work easier, it helps the whole class too.

6. C.A.M. always gives you a second chance. On the old tests, if you got a question wrong, you were marked down for your mistake and you probably never got another chance to do better on that question. With C.A.M., on the other hand, each test contains every type of question. So if you miss a question once, you will soon have a second chance to try to do better.

7. C.A.M. tells you exactly what you are expected to learn in a course at its beginning. Your teacher will give you a list of "course objectives." These are the things which you will learn in the class. Since you know from the start what you will be doing, you will not have to guess what the teacher wants from you.

What Does C.A.M. Do For The Teacher?

Teachers get reports back after each test too. This allows them to:

- give you individual help on what you don't know,
- make the course better by reviewing the things with which the class as a group is having trouble,
- improve instruction by not repeating what students already know,
- study which ways of teaching help students learn best.

FUNCTIONS

1. Retrieve, call up, and print, a complete list of content area objectives.

2. Retrieve and print objectives by teacher, section or class.

3. Provide updated list of objectives completed (by student) and date, along with a list of objectives not completed.

4. Updated class grouping report and summary information, with text references, and page numbers.

5. School Summary Information: Updated teacher lists of percent of student mastery within a given class.

For each objective, you will have to indicate the number of items for that objective. You may have a maximum of 20 items for each objective. There are several options for your answers:

1. Each item will have one answer only. If your test is a single short answer, True-False or Multiple Choice you will select this option.

2. 1 or more items will have multiple or alternate answers. If an item has 2 or more answers, or if you have more than one correct answer, then you choose this option.

3. Teacher (or Aide) will grade test and input answers. If a test item cannot be machine graded (eg. an essay question, or a geometry question etc.) then choose this option. You will indicate the number of items only since the test will need to be teacher graded.

This project which was developed with additional money given by the U.S. office of Education has been declared as an exemplary project.

It is available to other districts...Time and money, however, needs to be budgeted so that the teachers can get together to work on compiling their course objectives and test items.

CASE STUDY II

Introduction

Advances in the state of the art have reached the point where computer-based instructional systems may reasonably be expected to make sustained contributions to the educational process. Indeed, the key to the improvement of the educational process lies in the identification, development, and dissemination of new instructional techniques that truly contribute to the intellectual well-being of the learner.

The Instructional Management Program (IMP) is one approach to the improvement of the educational process at the basic education level. The intent of the effort was to develop a prototype instructional system for schools in the Philadelphia School District that would offer a basic education program as part of the larger educational environment. This prototype has been successful and is in operation in a number of schools reaching approximately 4000 students a year.

Goal

The Instructional Management Program (IMP) undertakes to provide a basic education program of individualized instruction specifically designed to bring students to defined levels of mastery. In contrast to the traditional classroom, where students move as a group through a particular curriculum, IMP students are typically working on diverse materials which they should have, but did not previously master. The underlying assumption of this program of individualized instruction is that every child can master materials which conform to his unique learning characteristics. Individualization is realized by assigning materials which are academically required and conform to the manner in which each student assimilates information best.

Overall Description

The Instructional Management Program (IMP) is an educational program designed to insure that each student masters certain basic objectives used in the Philadelphia School District considered basic for students who are entering secondary school. Using a computer-managed approach to coordinate student evaluation information with carefully constructed individualized instructional materials, each student is taught in a manner that conforms to his individual learning characteristics, educational needs and interests.

The measurement and evaluation system is a well-refined testing program, unique to IMP, that is designed to measure each student's learning characteristics and his knowledge and understanding of defined educational objectives. There are two learning style measures:

an auditory test and a visual test. Scores from these help to determine whether a student learns better by hearing or by seeing the instructional materials. There are two measures of cognitive style: a test of concrete thinking and a test of abstract thinking. These help to determine whether material should be primarily a set of examples or should be a more general "rule" about the topic being presented. Combined with information about reading level and verbal ability level, the learning and cognitive style data form a profile of the student's learning characteristics.

Tests are administered in each content area (communication arts, mathematics, science, and social studies) to find out precisely which of the defined objectives have been mastered and which have not. This helps to ensure that students will not receive material they already know nor will they receive material that is too difficult for them.

These evaluations provide information to be used to match, by computer, the student's profile of learning characteristics and needs to the available bank of instructional materials. All instructional materials are "coded" so the teaching style conforms to the learning style of the student. For example, arithmetic skills (e.g., addition) could be taught in a visually-presented, drill-and-practice mode or, perhaps, by an auditorially-presented, abstract rule. The reading comprehension level of the material could also vary. The computer match system ensures the best match possible between the learning style of the child and the teaching style of the materials.

The program consists of three main components; an evaluation system which measures each child's learning characteristics and his mastery of the stated objectives; a curriculum bank of independent learning packets which are sequenced and coded as to objective and the various learning characteristics; and a computer management system which matches the learning activity to the needs and characteristics of the student.

Students are measured on their mastery of 69 objectives.

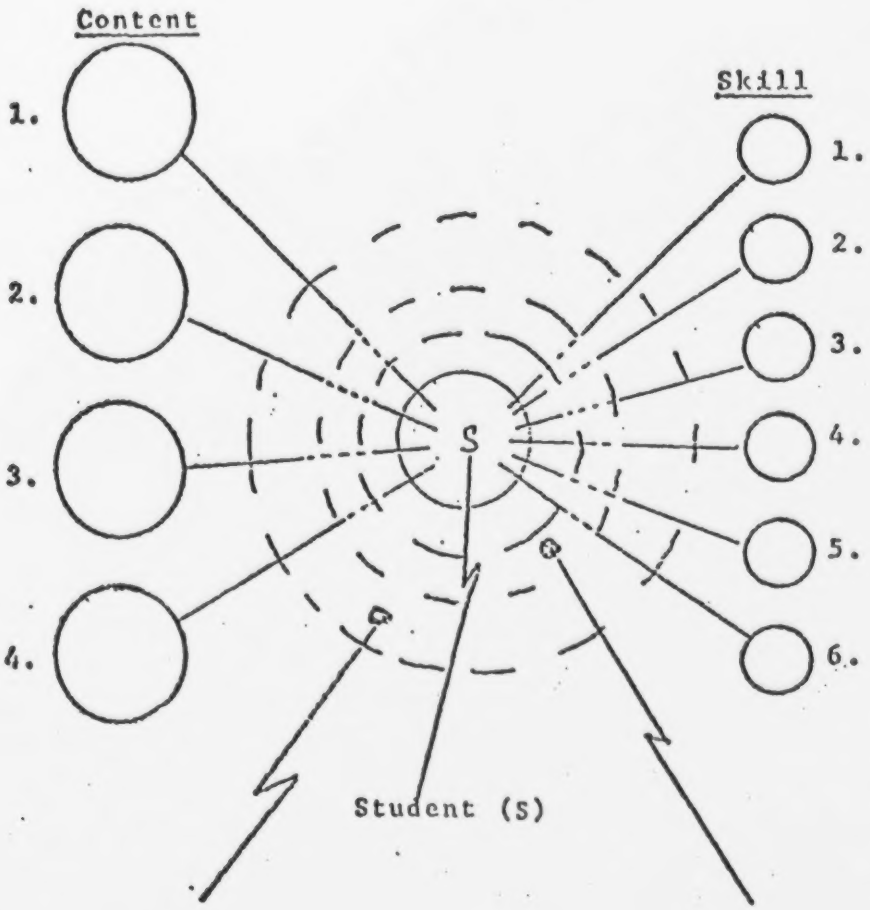
These objectives cover four content areas (communication arts, mathematics, science, and social studies) and six "skill" areas (creative thinking, critical thinking, effective communication, effective social behavior, learning strategy, and personal responsibility). They have been arranged in priority order. The measured learning characteristics include reading level, ability level, learning style (auditory or visual) and cognitive style (abstract or concrete).
SEE chart 1

Each participating student spends from 80 to 100 minutes per week in a individual Prescription (IP) Center, following the sequence of learning activities prescribed for him. He receives his "prescription" from the computer by typing information on the terminal located in the Center.

The student begins by selecting one of the highest-priority objectives in which he has shown a deficiency. He "activates" the objective in his record by typing his name or ID number and the objective number on the terminal. He is assigned a diagnostic test which will determine

INSTRUCTIONAL MANAGEMENT PROGRAM

Curriculum Areas*



*Curriculum Areas

Content	Skill
1. Communication Arts	1. Personal Responsibility
2. Mathematics	2. Effective Communication
3. Science	3. Effective Social Behavior
4. Social Studies	4. Learning Strategy
	5. Critical Thinking
	6. Creative Thinking

which topics in the sequence he already knows. He records the results of the diagnostic test on the terminal and receives his first "prescription" - the packet which best matches his learning characteristics and is on the first needed step in the sequence leading to mastery of the objective.

When he finishes the packet, he takes a short Progress Test to show his mastery of the material presented. If he passes this test he is assigned the "best match" packet on the next sequential step. If he fails this test, a Center supervisor decides whether he should repeat the packet, take another packet on the same topic, continue in the sequence, or temporarily switch to another objective. He records this decision on the terminal and receives the appropriate assignment.

After completing the sequence of packets within an objective, the student retakes the original "mastery" assessment. If, as is usual, he passes it, he records this information and chooses another objective from the list supplied by the computer. If he still fails, he is given tutoring by the Center supervisor or a student tutor until he can pass.

Students who have no deficiencies work on "enrichment" packets of their own choosing.

The essential feature of this program of individualized instruction cover:

(a) Objectives are defined, their importance established, and measures of performance administered.

(b) Children realize they have a serious weakness, know the nature of the deficiency, and agree to concentrate attention on its remediation.

(c) A structured program of learning is provided and tutorial help is given when serious difficulties are encountered.

(d) Children are allowed to proceed at their own pace and indications of progress are given at frequent intervals.

(e) The students know when they have successfully completed an objective and are rewarded by a certificate of achievement.

(f) No stigma is attached to the remedial learning process since every eighth grade child was scheduled to the Center and each worked privately on their individual learning problems.

The Basic System Structure

The system is designed to find out what children need and to supply the most appropriate learning experiences to meet these individual needs. The prototype consists of three basic components: a set of instruments and techniques for assessing student needs, a bank of curriculum packets related to assessed needs, and a computer-based system for relating individual needs to available curriculum options.

Student Evaluation System

Individual treatment begins with an evaluation of the strengths and weaknesses of each student.

A. Terminal Measures

This system focuses exclusively on basic school objectives which are defined as the minimal requirement needed to succeed in secondary school The teachers defined their school objectives by identifying those facts, principles, and operations that they expect every student to remember, understand, or perform by the time he completes four years of study in mathematics, science, social studies, and communication arts.

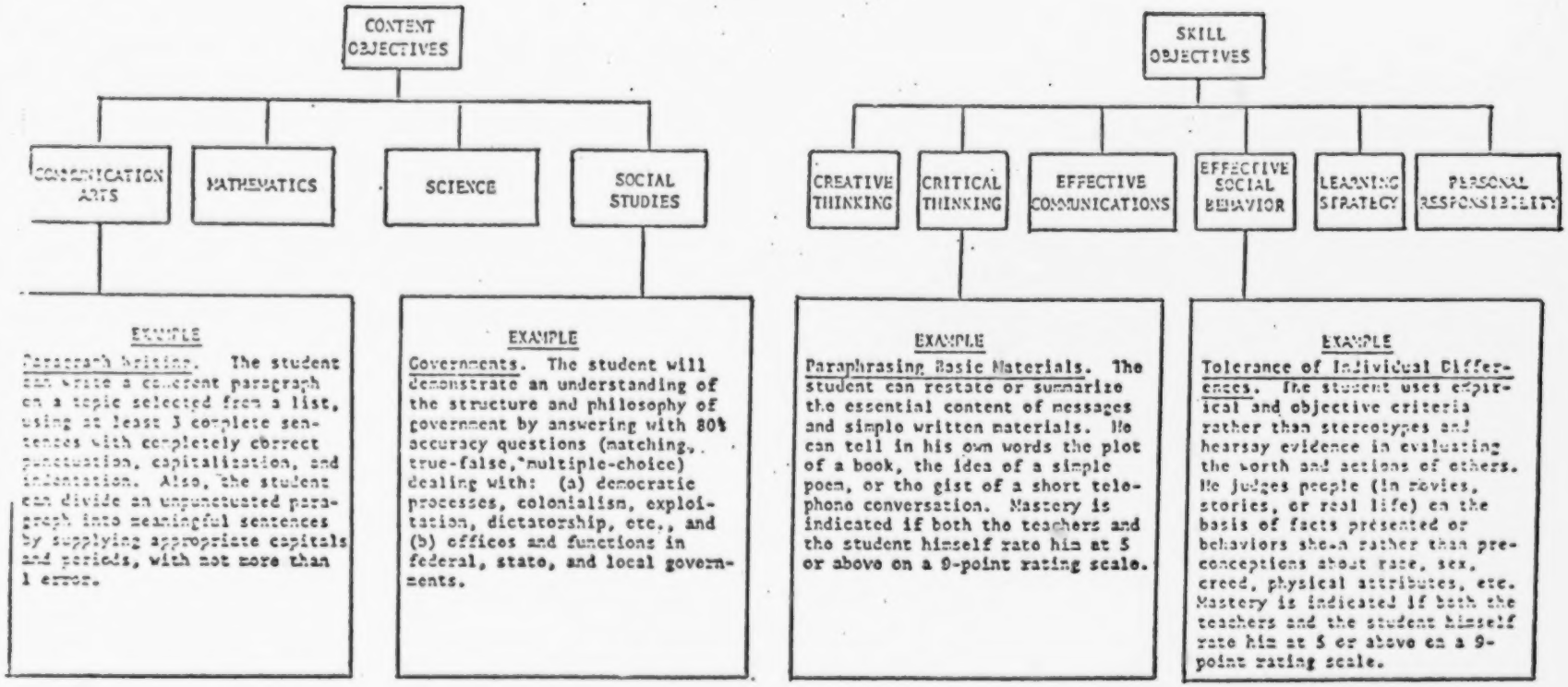
Added to these were a series of "skill" objectives defining the minimal levels of proficiency in more general skills which cut across the various subject-matter areas. Examples of these are "differentiating fact and opinion", "independence in learning" and, in the affective domain, "empathy toward others" and "tolerance of individual differences." See Chart #2

The content and skill objectives behaviorally defined by this process have been ordered in priority of importance by the school staff and serve as the foundation of the system's curricular content and direction. They are reviewed and revised annually by the teachers in light of the previous year's experience.

The next task involved the development of measures of mastery of these objectives. Tests were written for all content objectives, and rating scales (used by both students and teachers) were developed for evaluating students in the skill areas. These terminal measures are scored according to a predetermined criterion of mastery and pass-fail information is entered in a student data bank.

CHART 2

BASIC OBJECTIVES


CONTENT OBJECTIVES
COMMUNICATION ARTS
MATHEMATICS
SCIENCE
SOCIAL STUDIES
SKILL OBJECTIVES
CREATIVE THINKING
CRITICAL THINKING
EFFECTIVE COMMUNICATIONS
EFFECTIVE SOCIAL BEHAVIOR
LEARNING STRATEGY
PERSONAL RESPONSIBILITY
EXAMPLE
Paragraph Writing. The student can write a coherent paragraph on a topic selected from a list, using at least 3 complete sentences with completely correct punctuation, capitalization, and indentation. Also, the student can divide an unpunctuated paragraph into meaningful sentences by supplying appropriate capitals and periods, with not more than 1 error.
EXAMPLE
Governments. The student will demonstrate an understanding of the structure and philosophy of government by answering with 80% accuracy questions (matching, true-false, multiple-choice) dealing with: (a) democratic processes, colonialism, exploitation, dictatorship, etc., and (b) offices and functions in federal, state, and local governments.
EXAMPLE
Paraphrasing Basic Materials. The student can restate or summarize the essential content of messages and simple written materials. He can tell in his own words the plot of a book, the idea of a simple poem, or the gist of a short telephone conversation. Mastery is indicated if both the teachers and the student himself rate him at 5 or above on a 9-point rating scale.
EXAMPLE
Tolerance of Individual Differences. The student uses empirical and objective criteria rather than stereotypes and hearsay evidence in evaluating the worth and actions of others. He judges people (in movies, stories, or real life) on the basis of facts presented or behaviors shown rather than preconceptions about race, sex, creed, physical attributes, etc. Mastery is indicated if both the teachers and the student himself rate him at 5 or above on a 9-point rating scale.

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B. Diagnostic Tests

Mastery of most of the basic objectives requires the student to perform or comprehend a number of component operations or concepts, each representing one segment of the total objective. A "diagnostic" test is used to determine which segments of the objective, among those available for presentation in packet form, have already been mastered by the student and, therefore, should be eliminated from his learning prescription.

C. Measures of Learner Characteristics

Four variables are measured which seem to represent important dimensions of learning ability.

1. Reading level. Standardized test results are used to indicate a student's reading level. One of three levels is entered in the evaluation file.

2. Aptitude level. Scores from mental ability tests are categorized as "below average" or "average or above" for input into the student file.

3. Learning style. Learning style is defined as the profile of a student's relative ability to learn via visual, auditory, or kinesthetic-tactile sensory pathways. Instruments were constructed to present comparable learning tasks in these three modalities. Students who showed marked strengths in one modality were categorized appropriately.

4. Cognitive style. Children's mental processes may be especially suited to learning either concrete or abstract relationships. To master the same material, a concrete learner requires many specific examples and step-by-step development of a concept or operation, while an abstract learner requires only a general explanation or rule and a few examples. See Table 1

D. Progress Tests

These tests are designed to measure mastery of the material presented in each learning packet. A "pass-fail" decision for every packet the student completes is entered in his evaluation file.

TABLE 1

NAME	TYPE OF STUDENT INFORMATION PROVIDED
RDLC Profile	Learning characteristics of students representing best presentation method. On the basis of their likely stable and significant influence upon the learning process the following variables are used: Reading grade level (3 levels are provided for) Difficulty level (2 Levels are provided for) Learning Style Modality Preference (auditory, visual and mixed - no preference)
Content Area Profile	Academic needs of student in 40 behaviorally defined objectives within the four traditional content areas-mathematics, communication arts, science, and social studies. Student is classified as either having or not having attained defined levels of mastery in each content area objective.
Skill Area Profile	Needs of student in behaviorally defined skill area objectives. In contrast to the subject specific content objectives, skill objectives address themselves to more general areas of cognitive and affective maturity, such as categorizing concepts, differentiating fact & opinion, and appreciating individual differences.

The Curriculum Bank

The basic unit of the curriculum bank is a learning packet involving independent or semi-independent learning activities. Each packet consists of a statement of the packet objectives, a unit of instructional material, and a progress test. Some packets include all of the instructional material, others direct the student to books, records, filmstrips, or other materials.

The development and sequencing of these packets ideally requires careful analysis of the component steps leading to mastery of each objective. Determining prerequisite levels in arithmetic is relatively simple; in areas such as empathy toward others, any given sequence may be difficult to justify on logical grounds. Teacher judgment of what seems a sensible order is used.

Learning packets teach the segments in ways reflecting the variety of learning characteristics which have been measured. Each packet is coded in terms of the nine characteristics the code-number ranges. Three designations have not been explained above: "Category" specifies whether the packet teaches toward a skill or content objective, "Area" indicates the general classification within category (e.g., science, creative thinking), and "Alternatives" is used only when there are two packets with identical coding on the first eight variables.

Thousands of possible packet variations can be conceived for teaching a complex subject involving many discrete learning steps (e.g., reading). The actual preparation of so many variations is not practical nor would it be desirable in an untested model. Enough variations have been written for many topics, however, to serve as a basis for testing the usefulness of these variables in structuring the learning experiences of children.

Computer Management System

The system is designed to prescribe a learning path for each student corresponding to his individual needs.

A. System Operation

A remote computer terminal is located in a school. Telephone lines link the terminal to a partition of an IBM System central processing unit. The system operates mainly in the on-line processing mode, with provision for remote batch operation as well. The major on-line use is by the students who request their own packet assignments at the terminal and receive immediate decisions. The remote batch mode is used when the full computer system is needed.

B. Decision Making Process

The first major decision is the choice of a particular objective for student concentration. The next decision point is reached as the student takes the diagnostic test for the selected objective to indicate which packets should be eliminated from his prescription.

The third decision is the focal point of the system. The rapid selection of the appropriate packet for a particular student at a given time is one reason for automating the system to utilize the speed of a computer. A matching algorithm is used to prescribe a learning assignment which represents the best fit between the student's learning abilities on the one hand and the available variations in learning treatments on the other.

The final decision is made after the student completes the packet assignment, takes the progress test, and returns to the center supervisor for an evaluation. In the "pass" case, the student returns to the terminal, records the successful packet completion, and receives another assignment in the sequence. In the "fail" case, the center supervisor must reach one of the four decisions shown in the chart. The student then returns to the terminal to record the decision reached and to receive new instructions.

The Results

Students participate in the program for approximately 10% of the instructional time during the year. Many of these students have low scholastic aptitude test scores and a history of serious learning problems. Their performance show that practically all students can learn the basics.

The program, though difficult to implement due to the number of individualized packets required, is successful in achieving its goal. A computer is being considered for the future development of the program.

CASE STUDY III

Overview

This system has been developed by Bertamax, Inc., Seattle, Washington, for use with a number of microcomputers in any subject area. It is being used fully in a number of secondary schools. It is dependent on pre and post tests of instructional objectives. The instructional objectives test items for the content component of the system. The student types the answer in the computer, the test is scored and the student's file is up-dated.

Reports showing the status of a student's performance are available to assist the teacher in helping students master the objectives. Reports are also generated for the parent which describes each objective mastered by the student. Prescriptions for students who fail to achieve mastery are provided based on the "keying in" of learning tasks for each of the objectives. Two disk drives on the microcomputer are required and a 48K system is the minimum size machine that can be used.

Operation

The program requires the construction of files of objectives and test answers. The system is menu driven. After all the files are loaded, nine choices appear.

---> OPTIONS FOR CUSTOMIZED INSTRUCTIONAL MANAGEMENT SYSTEM

- o HELP (HINTS FOR USING THE SYSTEM)
- o TESTS (INPUT TEST ANSWERS)
- o LIST (LIST OF STUDENTS)
- o REPORTS (REPORTS OF STUDENT PROGRESS)
- o STUDENT/RECORD (ADD A STUDENT/CHANGE A STUDENT RECORD)
- o STUDENT/CHANGE (CHANGE STUDENT INFORMATION)
- o STUDENT/DELETE (DELETE A STUDENT RECORD)
- o TEACHER (ADD, CHANGE OR DELETE TEACHERS)
- o UPDATE/EXIT (UPDATE THE FILES AND EXIT THE PROGRAM)

PLEASE CHOOSE THE UPDATE/EXIT OPTION BEFORE REMOVING DISKS

There is a help option both on using the system and a particular item to be presented.

The student works the test with paper and pencil and inputs the answers only. The computer processes the results. When all answers have been typed, the student's score is displayed. The mastery level's set at 80% but a teacher can change that for its class.

The teacher may obtain a student progress report on the skills or on the printer. Due to the physical limitations of the equipment there is a difference in the number of objectives. Reports may be received on the entire class on individual students, separated according to the alphabet, or by those who have not passed a particular objective.

The file for each student can be searched to determine all objectives that have been mastered. Time for searching file can be reduced by selecting range of objectives.

NAME OF TEACHER PATTERSON, AUDREY

NAME OF STUDENT GRANT, LOUIS

Objective Options

- o Complete File Search
- ---> o Objective Number or Range (Ex.2-9)

Message can be sent to a student, a parent or a teacher. The student's name is printed so that the message is personalized.

Parent (Guardian) Messages - Beginning Sentences

- o Your child has mastered the instructional objectives which are listed below.
- o Your child, (NAME) is making outstanding progress.
- o Your child, (NAME), is performing satisfactorily.
- o Your child, (NAME) could put more effort into work.
- o None of the above. (A personal note only)

NOTE: All messages will include the first message.

Up to 5 sentences may be included with the message.

Personal Note
Type each sentence then press <ENTER>. Each sentence must be shorter than 3 lines on the screen. As you type, a word may appear split on two lines on the screen, but I'll take care of it when I print the message.

Type Sentence 1
? I appreciate your outstanding effort Louis.

References or prescriptions for each objective, if entered in the system, can be printed.

JANUARY 1, 1990
THE TITLE OF YOUR TESTING PROGRAM
TEACHER: AUDREY PATTERSON
STUDENT: LOUISE GRANT

Objective 6 - Verbal Story Problems (Addition and Subtraction)

#	PUBLICATION TITLE	PUBLISHER	YEAR	REFERENCE
3	ADDITION AND SUBTRACTION WITH A HAPPY ENDING	CREATIVE PUBLICATIONS	1977	PAGES 9,12,15 18,33
5	GOOD IDEA BOOKS _ FUNTASTIC CALCULATOR MATH	ENRICH, INC.	1978	PAGES 24-26
1	THE CALCULATOR WORK BOX	ADDISON-WESLEY	1978	CARDS 27-45

The references are to be kept short for each objective. There is a limit of 255 characters. As its prescriptions are entered, the amount of space remaining is stated.

Placement

Each student's strengths and needs are diagnosed by means of a diagnostic test. The test is criterion-referenced and measures a student's mastery of specific educational objective. Proper placement of each student is a vital step in the learning process.

Uses of the Computer

- evaluates the student's needs by evaluating a placement test
- prescribes off-line (away from the computer) learning activities for mastery of each needed objective as shown by the placement test
- evaluates mastery of the above objective and prescribes further activities to master that skill
- measures long-term retention of objectives by a post test
- provides the teacher with a list of any objectives still needing work
- provides the teacher with a manual over-ride at any step in these procedures
- assists the teacher by providing a series of reports to show status and progress of the students. Also, upon request

provides letters to parents explaining students' progress

Evaluation

This system, among others, are sold to schools in the U.S. It is a fairly standard management system which does achieve its purpose. It is, however one of the few systems using the microcomputer successfully. The need for a two disk drive system does increase the cost and make the system more difficult to work with. Complaints have been made due to the necessity of working with two disk drives. However, since records can be kept for a maximum of 600 students (40 for each of 25 teachers) it is understandable that on a microcomputer the second disk is needed. The Generalized Management System achieves its goal.

Acceptance is mixed. Some teachers believe it creates more work for them. In addition, there are those who do not take advantage of the opportunity of individualization which the system provides.

Modern systems of Computer Managed Instruction involve branching, individualized programs of study and information flow to help the teacher to monitor, test, evaluate, and direct progress. Much of the drudgery of of administering individualized systems can be eleminated by appropriate uses of computers, and important aspect of motivation and guidance are provided.

Computer Managed Instruction, like all systems for individualized instruction, has still difficulty in being implemented. Programs for teacher-training reorientation and the teacher's role in the classroom, is still being defined. The preparation of behavioral objectives and learning materials is another basic area that could cause difficulty.

CONCLUSION

Using the capabilities of the computer in Computer Managed Instruction permits:

- Generating of tests, based on the student's past history and knowledge of the subject. For example, if a student reaches the criterion level on four of five learning objectives, the terminal generates test items on only the one objective the student missed. It also is used to generate alternate exams over the same objectives or to generate tests which have items at various levels of difficulty. Thus, the degree of knowledge can be checked from recall, to synthesis or evaluation.

- Correcting of tests and generating individual instructional prescriptions based on scores received on test items missed. A printout can give prescription or diagnosis of results from the test.

- Managing of instructional resources such as the individual student instructional carrels, the course hardware and instructional supplies, the media hardware (projectors, video tape units, etc.), the mediated course materials (programmed texts microcomputer terminals, tape-slide carrels and video tape systems)

- Managing data such as the meantime between instructional presentations, student records and progress, test item validation, reliability of test forms, pre-assessment and post assessment data.

In short, the computer performs all of those menial bookkeeping tasks normally performed by an instructor during conventional instruction.

SUMMARY

Computer Managed Instruction is beginning to emerge as an important new "total systems approach" to education which uses a flexible approach and offers a non rigid or adaptive curriculum with the benefits of solving problems independently using classroom psychology and a multi-media instructional setting.

The computer with its data handling capacity marks a new age towards significantly individualizing instruction. The processing of scores on tests, aptitudes, interests, attitudes, and levels of student performance, provides the opportunity for instructional alternatives in a multi-media educational environment. If education is designed to discover and place the concepts of knowledge and the forces which govern them within reach of each individual, the specific contribution of CMI as a system provides an opportunity for this to be accomplished.

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JUNE 1983 S. CHARP

Also available on request:

Complete list of documents available free from the Division
Catalogue of Unesco publications
Sample copy and subscription information on
Prospects, quarterly review of education

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DATE FILMED

AUG 17 1987